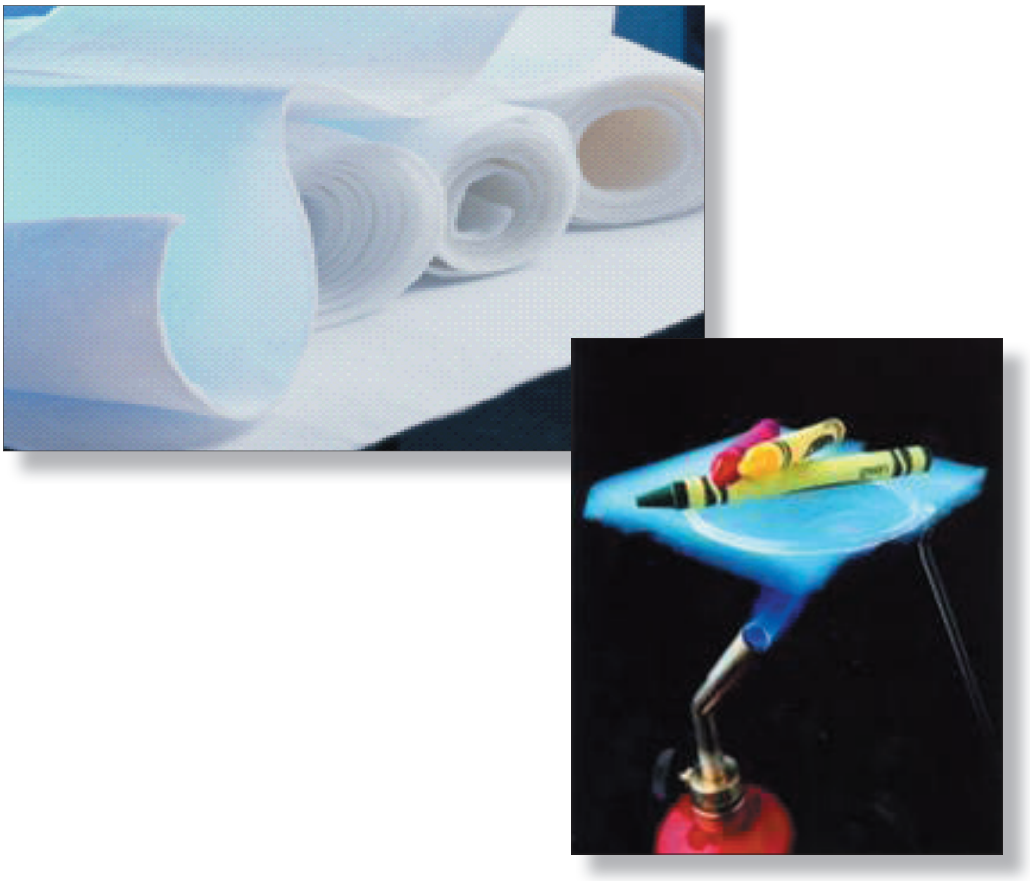
Air Force Research Laboratory|AFRL

Science and Technology for Tomorrow's Air and Space Force

Success Story

ULTRALIGHTWEIGHT AEROGEL-BASED THERMAL INSULATION



The Space Vehicles Directorate and Aspen Aerogels, Inc. developed and demonstrated an ultralow-density aerogel-based thermal insulation, designed to replace multilayer insulation (MLI) for a variety of space missions such as the Space Tracking & Surveillance System (STSS). Raytheon Space and Airborne Systems Company sees this new insulation technology as one of the keys to overcoming thermal challenges facing future STSS payload designs and avoiding some of the thermal modeling problems that have delayed the current generation of sensor payloads.

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Accomplishment

Under the Directorate's sponsorship, Aspen Aerogels developed a cost-effective, ultralightweight aerogel-based thermal insulation. The optimization of the formulation and process variables led to the successful demonstration of the ultralightweight (2-4 pounds per cubic foot) insulation. The thermal conductivity in vacuum (10-3 torr) of the materials fabricated is around 1 mW/m-K (milliwatt per meter-Kelvin) at 160°C (the maximum temperature expected for exposure to Solar Albedo in low earth orbit [LEO]). This corresponds to a thermal resistance value of better than R-140/inch thermal resistance in the most challenging LEO environmental conditions.

With its thermal conductivity of R-15/inch at ambient terrestrial conditions and R-140/inch+ under LEO conditions, the flexible aerogel ranks significantly better than all other high-performance insulations. As a replacement for MLI, the flexible aerogel blanket offers equivalent thermal performance in vacuum; significantly better thermal performance in atmosphere; faster off-gassing rates; and dramatic improvements in integration time, touch labor and, ultimately, system cost.

Since the insulation material is a solid versus a series of interlaced blankets, as with MLI, the aerogel insulation technology promises to be far more reliable in terms of thermal insulation performance delivered, repeatability, and the ability to model accurately a system's thermal performance. The aerogel blanket is not sensitive to thermal shorting by compression, a common failure mode for MLI. (MLI typically is good for two installations before compression compromises the system irreversibly.)

Background

Parasitic heat leaks on cryotelescope platforms degrade sensitivity and mission performance. Once validated for STSS, the aerogel insulation technology will be directly applicable to a number of other US military systems, such as the exo-atmospheric kill vehicle on the ground-based midcourse interceptor, as well as the high-altitude airship and the airborne laser. Virtually any US space platform requiring thermal management will benefit from the successful development of the aerogel insulation system.

Space Vehicles
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (04-VS-09)